

DOCUMENT RESUME

ED 328 573

TM 016 072

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TITLE The Effect of Collaborative Testing on the Test Scores and the Classroom Attitudes of Junior High School PreAlgebra Students.
PUB DATE 90
NOTE 32p.
PUB TYPE Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Comparative Testing; Grade 7; Grade 8; Grade 9; Junior High Schools; *Junior High School Students; *Mathematics Achievement; Questionnaires; *Scores; *Student Attitudes; Test Results; Test Use
IDENTIFIERS *Collaborative Testing; Curriculum Based Assessment; Pre Algebra; *Testing Effects

ABSTRACT

The effect of collaborative testing on junior high school students' scores was investigated. Twenty-two students in grades 7, 8, and 9 were given curriculum-based tests in their pre-algebra classes. Some tests were taken individually in the traditional manner, and others were taken collaboratively by students in pairs over a 10-week period. Collaborative and individual scores were compared, and collaborative test scores for 1990 were compared with individual test scores for 1989. A questionnaire was administered to the subjects to determine their reactions to collaborative testing. Questionnaire results indicate that all students preferred the collaborative testing. Test scores showed a mean improvement of 9% over the 10 weeks, while the previous year's students, tested traditionally, had dropped 5% during the same time period. These findings indicate that: collaborative testing offers an effective way of improving achievement in certain classes, and student attitudes toward classes can be positively affected by collaborative testing. The study questionnaire and two tables of test results are appended. A 42-item list of references is included. (Author/SLD)

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Collaborative Testing

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The Effect of Collaborative Testing On the Test Scores and the Classroom Attitudes of Junior High School PreAlgebra Students

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Running Head: THE EFFECT OF COLLABORATIVE TESTING

Tm016072

Abstract

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The effect of collaborative testing on junior high school students' scores was investigated. Twenty-two students in grades 7, 8 and 9 were given curriculum-based tests in their pre-algebra class. Some tests were taken individually in the traditional manner, and others were taken collaboratively by students in pairs over a ten-week period. Collaborative and individual test scores were compared, and this year's collaborative test scores were compared with last year's individual test scores. A questionnaire was given to the subjects to determine their reaction to collaborative testing. The results of the questionnaire indicate that all the students preferred collaborative testing. The test scores showed a mean improvement of 9% over the ten weeks, while the previous year's students, tested traditionally, had dropped 5% during the same time period. These findings indicate that collaborative testing offers an effective way to improve achievement in certain classes and also that student attitudes toward classes can be positively affected by collaborative testing.

The Effect of Collaborative Testing

On the Test Scores and the Classroom Attitudes
of Junior High School Pre-Algebra Students

For nearly twenty-five years teachers and researchers have built a strong case for the positive effects of cooperative learning on student achievement and attitude (e.g. Johnson & Johnson, 1981; Slavin, 1988). However the subject of cooperative or collaborative testing has received little attention.

This study is an attempt to determine the effect of collaborative testing on the test scores and attitudes of junior high school pre-algebra students. Collaborative testing refers to the process in which two students take a test together, using whatever strategies they choose in order to find identical or differing answers. Accountability in this case is individual. This method of testing is seen as part of the cooperative learning process, rather than merely as a means of assessment.

Previous studies indicate that cooperative learning improves student achievement in all subjects at all ages (Johnson, Maruyama, et al., 1981; Johnson & Johnson, 1986). High, medium, and low-achievement students all benefit academically from participation in heterogeneous learning groups (Yager, Johnson, & Johnson, 1985). The benefits of cooperation can be practical as well as academic, as shown by a Russian study of cooperative groups' work on mitten

design (Tsukermann, 1981).

Besides the academic and problem-solving benefits of cooperative learning, there are also extremely important social and psychological benefits. Robert Slavin and others have demonstrated that cooperative learning teamwork improves social interaction, race relations, and increases self-esteem (Slavin & Karweit, 1981). A study of small group math instruction showed that cooperative work not only raised the achievement of all students in higher-level skills, but also tended to erase inequities among students (Taylor, 1989).

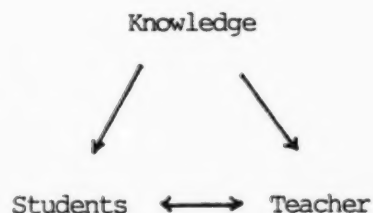
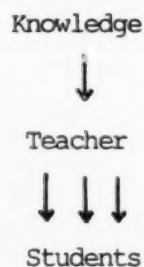
The psychological and academic benefits of cooperative learning are closely linked. When researchers inspect how cooperative learning works, they invariably point to the benefits of verbalizing the problem-solving process (Lindquist, 1989; Yager, 1985). By discussing, questioning and correcting each other, students master the material more completely (Kohn, 1987) and retain it longer than students who study individually (Yager, Johnson & Johnson, 1985). The ability to discuss concepts, explain them to peers, ask questions, etc. benefits students intellectually as well as socially and psychologically (Lindquist, 1989).

The effectiveness of cooperative learning can also be explained by the increased motivation born out of peer interaction. David Johnson points out that it is hard to end cooperative group sessions

(Kohn, 1987). For some reason, students who have a positive experience of cooperative learning become more intrinsically motivated. In a second meta-analysis (1986), Johnson & Johnson looked at 600 research studies to determine conclusively that students are motivated more in cooperative learning situations than in traditional classroom situations.

A study of mathematics content and small group instruction in grades four through six showed that cooperative learning tends to encourage students' taking responsibility for their own learning. This self-motivation takes management pressure off the teacher and generally improves the atmosphere of the classroom. The teacher is transformed from a conduit of knowledge and a disciplinarian into a facilitator and friend (Lindquist, 1989).

Cooperative learning has proven effective in the teaching of mathematics at the college level, as well. In an intermediate algebra class of 66 students, four-person student teams were used in a self-paced, self-testing format. The professor, James R. Norton, devised the following diagrams to contrast the traditional and cooperative learning formats:



In explaining how team or cooperative learning works, Norton quotes the adage, "To really understand something, try teaching it to someone else." He points out that much more individualized attention can be given and received in the cooperative classroom than in the traditional class set-up. This attention is given mostly by students. This frees the teacher to go where he or she is needed.

Norton allowed his students to take practice tests to check their progress. For items answered incorrectly on the post-test, the students were given the opportunity to restudy the pertinent objective and retake that test item. Here testing is being used not merely for assessment, but also as a means for furthering learning. The students came to view the taking of tests as a learning experience and anxiety levels were reduced.

A questionnaire was administered to the 66 students at the mid-semester point. On a scale of one to five (very high to very low) the mean assessment of the team method was 2.2 or "high." The mean rating for team compatibility was 1.9, which is not surprising since the students chose their own teams. One remarkable statistic is that 75% of the students stayed with the class while the usual figure was 50%. Based on the questionnaire, Norton concluded that about 20% of students did not function as well as had been hoped in the cooperative situation. He surmised

that this was because those people missed the usual lecture format (all the teaching was cooperative) and/or some students simply prefer working alone.

In comparing individual to cooperative learning groups, Mevarich, Stern, and Levita of Bar-Ilan University in Israel studied 115 junior high school students who used computer-assisted instruction. One-third of the students worked individually at their terminals while the other two-thirds worked in pairs. Students were assigned to each group based on achievement scores in order to assure homogeneity of the pairs and relatively equal ability in the two groups. The students' tasks involved identifying and classifying words.

The results were based on a comparison of achievement scores and attitudes of the two groups. Mean achievement scores in the cooperative groups were two points higher than in the individualized students. This difference was marginally significant ($p < .09$). Attitude, measured in a Sociometric Behavior Scale adapted from Kagan, et al., 1985, indicated significant differences. Cooperative learning students tended to increase their positive attitudes toward their team members ($p < .05$). The researchers concluded that the pairs of students became significantly more altruistic towards each other and towards all their classmates.

In assessing the benefits of cooperative learning, it is

essential to determine if group learning is transferred to each individual. Stuart, Yager, Johnson ^{and} Johnson point out that there is little research in this important area. They point to studies which indicate that when students summarize what they know and correct each other's summaries, acquisition and retention of learning is facilitated (Lockwood, 1983). Other researchers have concluded that dialogue and interaction between people is the most effective means of implanting information into memory (Baker, 1979). (Socrates must have known this when he questioned his pupils!) Other studies show that students who are asked to summarize what they know will subsequently recall more information than students who are not "tested" this way. Another study indicates that by explaining material to others, students undergo a different and comprehensive cognitive process than in learning the material for themselves (Annis, 1983). In the Mathematics Framework for California Public Schools, a rationale is given for cooperative learning groups.

To internalize concepts and apply them to new situations, students must interact with materials, express their thoughts, and discuss alternative approaches or explanations. Often, these activities can be accomplished well in groups of four students. Working in small groups increases each student's opportunity to interact with materials and with other students

while learning. Students have more chances to speak in a small group than in a class discussion; and in that setting some students are more comfortable speculating, questioning, and explaining concepts in order to clarify their thinking. By brainstorming, exploring various approaches, and solving problems cooperatively, students can gain confidence in their individual abilities.

When a cooperative climate has been established, small groups that are heterogeneous in their composition have the added value of promoting positive attitudes toward others, regardless of individual differences. As a group works together, the differences will be less important than the task at hand. More capable students can assist others. The questions asked by students who do not yet understand an idea will help the entire group to bring its thinking into focus. Individual strengths will be highlighted so that students who have difficulty in some areas will have a chance to contribute their special skills in other areas. (p. 16).

Since Dewey wrote Education and Experience (1939), educators have known that effective pedagogy provides experiences in which students can relate new concepts to old by interacting with materials and discussing their discoveries. Cooperative learning in its various forms encourages these experiences.

Perhaps more important than its effectiveness as a "delivery system" for curriculum, cooperative learning aids students' development of social skills, self-esteem, motivation, and problem-solving ability, and allows the teacher more face-to-face time with individual students (Johnson & Johnson, 1990). As a pedagogy, cooperative learning is content-free and adaptable to almost any learning situation (Brandt, 1989).

Curiously, though progressive educators have worked hard to make the classroom a more friendly and adventuresome place for students, testing is still used like the sword of Damocles to motivate, intimidate and assess learning and teaching. Combined with competitive grading systems, tests tend to add stress to the classroom experience.

Why does cooperative learning end at test time? Why does teaching need to end at test time? Can tests be used as more than assessment tools, and can test time be a time of intense learning? (Slavin, 1987).

Collaborative testing is a potentially powerful tool for encouraging student-to-student tutoring, increasing learning, and alleviating unnecessary stress in the classroom.

At the junior high level the powerful influence of peers is especially strong. Cooperative learning takes advantage of junior high school students' main interest: interacting with other junior

high school students.

The predominant experience of parents, shared by many teachers and administrators, is that nearly all peer group influences are inherently negative. They are seen as symbolizing challenges to adult authority and are to be strongly resisted as a necessary but undesirable dimension of growing up. (Fenwick, p. 12).

In Caught in the Middle, one of the Task Force Recommendations is for "cooperative learning strategies. . . as a means of building strong positive peer group relationships and reinforcing essential educational values and goals" (p. 69). Elsewhere the task force points out "The characteristics of young adolescents are too often interpreted as obstacles to learning" (p. 35). This leads to the recommendation of more active and cooperative learning in middle school classrooms.

Testing, it seems to the author, is an excellent opportunity for teaching and allowing students to help each other. To see testing as merely a "time of reckoning" or the strongest available motivator is to miss one of our best pedagogical opportunities.

Method

Subjects

The participants were the junior high school students in the author's Introduction to Algebra class. They were twenty-two

students in grades 7, 8 and 9. The entire class participated and took the math tests. Nineteen students were available to take the questionnaire.

Materials

The math tests were standard curriculum-based tests supplied by the text book author, John Saxon, for his book, Algebra $\frac{1}{2}$. He supplies two equivalent tests for each four lessons of material. Each test contains twenty problems worth five points apiece. Most of the problems are based on review work, since the text is designed incrementally, meaning that the various types of problems are reviewed in each lesson and test. About four problems dealing with the new material appear on each test. The questionnaire was designed by the teacher/author (see appendix).

Procedure

The students were tested once weekly for the first eight weeks. Some of the testing was in the traditional individualized mode. Other tests (usually every other) were taken collaboratively. In the last two weeks, students were tested twice weekly, first collaboratively, and then individually with equivalent tests.

When tested collaboratively, students were instructed to choose one person to work with. Most of the pairing was done by the students. When students were working alone, the teacher would pair them up. One time the teacher said, "Choose someone

you have not worked with before." On three occasions the teacher asked good students to team up with students who were struggling. Generally, however, students chose their own partners.

For collaborative tests, students were each given a test copy and were simply instructed to work with a partner. Each was expected to turn in a test. No instructions were given about strategies or about whether students needed to come up with the same answers as their partners.

At the end of the ten weeks, the students were given the questionnaire to determine their testing method preference, reasons, strategies, feelings about test anxiety, their attitudes about the class, etc.

Results

The results of collaborative testing as indicated by score comparisons and responses to the questionnaire were clearly positive. The test mean of individual tests taken after a collaborative pretest were 9 points higher than the individual tests taken before collaboration began. 100% of the students responding to the questionnaire said they preferred collaborative over individual testing.

Tests

Class test scores were compared to identical tests taken by another class the year before. On the first test, taken individually,

both classes scored a mean of 65. Ten weeks later, this year's class, taking an individual test after a collaborative pretest, scored a mean of 74, while the previous year's class mean dropped to 60, a net difference of 14 points.

The first time the class took a collaborative test, the class test mean jumped from the 65 to an 81 (an increase of 16 points). The scores on this test ranged from 65 to 81, while the previous year's class ranged from 45 to 90. Individual retakes of equivalent tests and tests taken at home were only 4 and 5 points respectively higher than the means of the previous individual tests taken in class. (See Table I in appendix.)

Questionnaire

Of the nineteen students who took the questionnaire, 100% said they preferred collaborative to individual testing. Asked why they preferred collaborative testing, students were allowed to give more than one reason.

100% responded, "I need help with some problems."

89% responded, "I understand problems better when I talk them over."

68% responded, "I enjoy working in pairs."

63% responded, "I get better grades when I work with someone."

58% responded, "I am less nervous about the test when I work with a partner."

53% said, "I like to help a friend."

Two students wrote in that they enjoying competing with their partners. Asked about strategies, 89% responded, "We work the problems individually, then compare answers." 79% said that when their answers differed from their partners, that they both reworked the problem. 79% of the students responded that they "learned more during a test working with a partner" and none said they learned less.

In terms of how collaborative testing affects their attitude about the class, 68% of the students said, "The class is more fun." 26% said, "It hasn't changed my attitude," and 5% (one student) liked the class less.

In response to the question, "Whose explanations of problems is easier for you to understand?", 53% said, "Sometimes students', sometimes teacher's." 40% said other students', 11% said parents', and 0% said the teacher's.

Discussion

The positive response to collaborative testing in terms of achievement and attitude exceeded the author's expectations. That every student said they preferred collaborative testing was a surprise, since two or three students would most often end up sitting alone after the others had paired off. These students never objected to being paired off by the author, however, and

were probably just shy, or ashamed of their inadequacy in math.

(All three were on the low end of the achievement scale.)

The difficulty of this particular course and the common student dislike of mathematics may have contributed to the universal preference for collaborative testing. The students, 100% of them, were frank in admitting that they needed help with some problems and 68% said that they simply enjoyed working in pairs.

The experiment started when the author began letting students take quizzes in pairs. They liked the experience so much that they would come into class and ask immediately, "Do we get to take a quiz today?" The atmosphere of the class started changing noticeably, and discipline became easier as teacher and students alike started enjoying the class more. Even tardies noticeably decreased as students came in with increased enthusiasm. Asked how collaborative testing affected their attitude about the class, 68% said, "The class is more fun." 26% said, "It hasn't changed my attitude," and 5% (only one student) said "I like it less."

An important question put to the students was, "Whose explanation of problems is easier for you to understand?" 53% responded, "Sometimes students', sometimes teacher's," but 40% answered, "Other students'," and no one said, "The teacher's." Whether this simply points to poor communication by the teacher

or to the fact that students prefer listening to each other is outside the scope of this study. But it is clear that students do benefit from the intense peer tutoring that goes on during a collaborative test.

The author in walking through the testing area heard students explaining the problem at hand (in urgent tones), and observed partners listening raptly, with one-pointed attention. Each was doing his part and would later sometimes reverse roles. 79% said they learned more during a test working with a partner. The test results and observations bore this out.

To determine how collaborative testing affected test anxiety, the author included a question about nervousness on the questionnaire. 58% of the students said, "I am less nervous when I take a test with a partner." 26% said, "I am no more nor less nervous when I take a test with a partner," and 5% (one student) said, "I am more nervous when I take a test with a partner." Observation verified that a much more relaxed atmosphere surrounded the collaborative than the individualized testing. The lowering of anxiety may also have contributed to the increased learning going on during collaborative testing.

Verbalization, theorized as a major contributing factor in the effectiveness of collaboration was not tested in this experiment, but teacher observation indicated that 80 - 90% of

the talking going on during the testing was about the task at hand. The pressure of testing insured that the students stayed on task.

To determine the effectiveness of group to individual transfer, equivalent tests were taken after the last two collaborative tests. The last individual test mean was 74%, 4 points higher than the collaborative pretest. The previous equivalent individual test was 78%, the same as the collaborative pretest. This would indicate successful transfer. The 74% on the last test is especially impressive when compared to the previous year's test mean of 60% on the same test.

When comparing the collaborative to the individual tests, the differences are great across the board. The collaborative test mean was 78% compared to 69%, a 9 point difference, and all the scores improved after the introduction of collaborative testing.

The students in the higher achievement range (80's and 90's) all improved when testing collaboratively (their mean score increased 9%). But students in the 60's and below improved much more (25 points between tests 17 and 18). We can conclude then that collaborative testing does tend to even class inequities, but not to the detriment of the higher achieving students.

The social effects of collaborative testing were not quantified in this study, but students were usually allowed to choose their

own partners and therefore got along well. One time a teacher-paired couple chose to work separately after having a squabble in spite of the teacher's attempt to help them reconcile their differences. Except for this instance, the students' attitudes towards each other and towards the teacher as well, noticeably improved.

Math testing is not necessarily the easiest or most appropriate area for collaborative testing. During the course of this study and English teacher at the author's school was encouraged to try collaborative testing in her seventh grade grammar class, and reported positive changes in her class' attitude and achievement.

One advantage of collaborative testing is that it requires almost no training, for the teacher or students, while other types of cooperative learning require much of teacher explanation and group practice. Two-person group work is simpler than larger group work because, in the words of David Johnson, "It's hard to get left out of a pair." (Kohn, 1987).

Because of its ease of implementation and the pedagogical benefits indicated by this study, collaborative testing would seem to deserve further study by teachers and researchers.

Questionnaire

Circle one except when told you may circle a number of answers.

1. Which testing method do you prefer?

- a) I prefer to take a test alone.
- b) I prefer to take a test with a partner.

2A. If you circled A above, answer this. You may circle as many as you want.

I prefer testing alone because:

- a) I get better grades.
- b) I don't enjoy working with a partner.
- c) I don't like other people using my answers.
- d) I get confused by my partner.
- e) I'm shy about working with a partner.
- f) I don't have any friends in the class.

2B. If you circled B above, answer the following. You may circle as many as you want.

- a) I understand problems better when I talk them over.
- b) I enjoy working in pairs.
- c) I gain confidence working with a partner.
- d) I'm less nervous about the test when I work with a partner.
- e) I get better grades when I work with someone.
- f) I like to help a friend.
- g) I need help with some problems.

8. Learning during a test:
- a) I learn more during a test working with a partner.
 - b) I learn less during a test working with a partner.
 - c) I learn no more nor less because of testing with a partner.
9. Whose explanation of problems is easier for you to understand?
- a) Other students'.
 - b) Teacher's.
 - c) Parents'.
 - d) Sometimes students', sometimes teacher's.
10. How has team testing affected your attitude about the class?
- a) It hasn't changed my attitude.
 - b) I like it less.
 - c) The class is more fun.

Table I

Means and Standard Deviations of Student Test Scores 1989 and 1990.

	1989 Individual		1990 Collaborative
	Class I	Class II	
Mean	65	60	65-81
Standard Deviation			

Table II

Key

= Student number (1 - 22)

Test numbers:

11A = Individual (i)

11B = Individual Retake (ir)

12 = Collaborative (c)

13 = Collaborative

14 = Individual

15 = Collaborative

16 = Individual

17A = At Home Test (h)

17B = Individual Retake

18 = Collaborative

19A = Collaborative

19B = Individual Retake

20A = Collaborative

20B = Individual Retake

*LYM = Last Year's Test Mean

Table II

#	11A i	11B ir	12 c	13 c	14 i	15 c	16 i	17A h	17B ir	18 c	19A c	19B ir	20A c	20B ir
1	75	85	94	100	85	85	--	--	77	90	85	95	72	93
2	80	--	--	75	74	90	80	65	--	--	75	75	67.5	95
3	100	--	99	100	100	100	92	94	90	100	85	--	90	--
4	65	71	66	90	62	55	50	89	50	79	49	65	89	52.5
5	25	44	59	58	67	60	74	70	85	68	44	70	70	75
6	35	45	69	80	60	55	58	52	55	90	70	69	92.5	57
7	65	56	74	90	44	64	35	52	55	70	85	69	62.5	64
8	70	67	90	90	69	--	80	79	55	85	77	75	62.5	60
9	55	52	75	100	67	71	74	59	59	100	74	69	75.5	80
10	60	70	85	95	79	72	69	90	70	70	95	95	72.5	--
11	80	89	100	99	78	94	74	85	58	75	97	94	75	70
12	45	83	83	85	57	66	65	90	45	85	55	65	72.5	75
13	60	75	--	95	75	70	88	87	75	75	80	95	89	85
14	75	71	90	80	78	85	--	74	80	88	--	95	92.5	100
15	90	--	95	100	89	100	90	95	95	85	95	95	77.5	95
16	75	76	90	75	68	66	50	65	65	70	95	76	65	55
17	74	76	83	79	70	65	69	64	50	79	89	--	65	--
18	75	76	84	79	88	90	88	73	84	84	89	90	67.5	72.5
19	50	66	79	90	61	85	60	95	55	85	80	60	65	75
20	71	75	80	85	64	70	60	84	72	84	75	79	55	72.5
21	50	--	64	90	60	50	49	59	24	50	74	64	40	--
22	45	--	70	85	60	60	50	18	65	43	--	60	92.5	60
Mean	65	69	81	87	71	73	68	73	65	79	78	78	70	74
LYM*	65													60

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